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Are accelerometer measures of temporal patterns of static standing associated with lower extremity pain among blue-collar workers?

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Highlights

- Short bouts of static standing were positively associated with hip and knee pain.
- Long bouts of static standing were positively associated with hip pain.
- Total standing time during leisure was positively associated with knee and hip pain.

Abstract

Background: Pain in the lower extremities is common among blue-collar workers, with prolonged static standing as a potential risk factor. However, little is known about the association between diurnal accelerometer measures of static standing and pain in the lower extremities, and the potential importance of temporal patterns of static standing for this association. *Research question:* We aimed to investigate the cross-sectional association between accelerometer measures of total static standing time and temporal patterns (bout duration) of static standing (short: 0-5 min; moderate: >5-10 min; and long bouts: >10 min) during total day, work and leisure and pain intensity (on a 0-10 scale) in hips, knees and feet/ankles. *Methods:* Accelerometers were used to measure static standing during four consecutive days among 677 blue-collar workers. Linear regression analyses were used to investigate the association between static standing time and pain intensity in the lower extremities. *Results:* Total static standing time comprised, on average, 3.9 hours per day. 72.6% of the workers were exposed to long bouts of static standing, averaging 0.1 hours per day. Short bouts of static standing were positively associated with hip and knee pain during total day, and positively associated with knee pain during work. Also, total static standing time during leisure was positively associated with knee and hip pain. A negative, but not significant, association was found for static standing in moderate bouts at work and hip pain. *Significance:* Even though the associations found were weak, these findings suggest that the temporal pattern of static standing is of importance for pain in the

lower extremities. Future research should examine the possibility that moderate bouts of standing could play a role in preventing lower extremity pain.

Keywords: accelerometry; musculoskeletal disorders; occupational health; physical activity; static stance.

1. Introduction

A considerable proportion of the Western population suffers from pain in the lower extremities [1]. The prevalence rates are 8-32% for knee pain [2–4], 9-20% for foot/ankle pain [5,6], and 5-11% for hip pain [6,7]. These prevalence rates are higher for workers engaged in physically demanding jobs [3,4,6]. One suggested risk factor is prolonged static standing that may induce muscle discomfort, fatigue, lowered blood flow, and increased venous pooling [8–10]. Accordingly, a cross-sectional [6] and a prospective study [11] have observed positive associations between self-reported standing at work and pain in the lower extremities, but other studies have not supported this finding [3,4].

One reason for these contrasting findings can be that the assessment of time spent on static standing has been based on self-reports [6,11,12]. Self-reported physical work demands are known to be both imprecise and biased [13,14]. To the best of our knowledge, no study has investigated the association between diurnal accelerometer measures of static standing during normal activities of daily living (ADLs) that are stratified into different domains (total day, work and leisure) and pain in the lower extremities. Some studies have investigated standing through step counts or accelerometers only at work [15,16] and lack measures of standing during leisure.

The time pattern of static standing – the time spent in specific uninterrupted bouts of static standing – can be of importance for pain in the lower extremities [15]. It is plausible that long static standing bouts can be a particular risk for pain in the lower extremities [8–10]. In contrary, short standing bouts are usually associated with alternation between postures during the workday [17], which can lower the sustained static load of the muscles, provide more variation in lower extremity muscle activation and consequently less local fatigue and venous pooling of blood in the legs. However, no previous studies have investigated the association between temporal patterns of static standing and lower extremity pain. Therefore, we studied the cross-sectional association between accelerometer measures of total time and temporal patterns of static standing and lower extremity pain in blue-collar workers. We hypothesized that: (1) total time and long bouts of static standing are positively associated with lower extremity pain (i.e., hips, knees, feet/ankles); (2) short bouts of static standing are negatively associated with lower extremity pain.

2. Material and Methods

This study used baseline data from a prospective study in Denmark – Danish PHysical ACTivity cohort with Objective measurements (DPHACTO) [18]. A total of 2107 workers from 15 companies engaged in cleaning, transport and manufacturing sectors volunteered to participate. Workplaces eligibility, and workers' inclusion and exclusion criteria are described elsewhere [18]. The study was previously approved by the Danish data protection agency and local ethics committee (H-2-2012-011) and conducted according to the Helsinki Declaration.

Eligible blue-collar workers (n = 909) were invited to take part in the study protocol. Self-reported information about pain in the lower extremities (hips, knees, feet/ankles) was obtained from 904 workers, and 734 of them participated in diurnal accelerometer-based measurements.

2.1 Accelerometry

Workers attached one Actigraph accelerometer (GT3X+, Florida, USA) at the midpoint between the iliac crest and the upper border of the patella of the right thigh [18] for four consecutive days. During the measurement period, workers also filled-in a short paper diary, reporting time of the reference measurements, working hours, going to bed and waking up in the morning, as well as the time of eventual removal and re-attachment of the accelerometers. The reference measurement consisted of an upright stance for 15 seconds each day to secure accurate activity detection and synchronization from the accelerometer signals.

Initializing accelerometers and recording and downloading of data were performed using the Actilife software (version 5.5, Pensacola, USA). The acceleration signals were sampled at 30 Hz, digitized using 12-bit A/D converter and stored. A customized MATLAB program – Acti4 (The National Research Centre for the Working Environment, Copenhagen, Denmark and the Federal Institute for Occupational Safety and Health (BAuA), Berlin, Germany) was used to identify various postures and physical activity based on accelerometer data. Specific parameters of the accelerometer data can be found elsewhere [19,20]. Acti4 identified 'static standing' if the inclination of the thigh was less than 45° and no movement of the thigh was identified [19]. The Acti4 software has a high sensitivity (80%) and specificity (> 90%) on estimating body postures, physical activity type, duration and variation both in semi-standardized and free-living conditions [19,21].

Bedtime and non-wear period were excluded from the analysis. Non-wear periods were identified when (1) artifacts or missing data were detected by visual inspection, (2) a period longer than 60 minutes without any movement (zero acceleration counts) was detected by the software, or (3) self-reported non-wear periods were registered by the workers on the paper diary [19].

2.2 Temporal patterns of static standing

Temporal patterns of static standing were derived from the specific time domains of work and leisure time, and total day (work + leisure). We selected three categories of continuous periods of standing (short: 0-5 min; moderate: >5-10 min; and long bouts: >10 min) based on previous studies. Short bouts of static standing (0-5 min) were selected as a proxy for breaking up sustained periods of standing or other physical activities [22]. Long bouts of static standing (>10 min) were defined based on previous laboratory and field studies [23,24], and recommendations of breaking up a sedentary behavior [25]. Moderate bouts of static standing (>5-10 min) were then defined as the period between short and long bouts.

Valid measurements were obtained from 698 workers in accordance with the inclusion criteria based on total day (measurement for at least 4 hours of work per day and in total 10 hours of measurement on that day) and from 677 workers in accordance with the inclusion criteria for analyses stratified on work and leisure time (measurement for at least 4 hours or 75 % of the average duration of work and leisure time respectively) (Figure 2).

2.3 Measurement of pain intensity

The intensity of pain in the lower extremities was reported using a modified version of the standardized Nordic Questionnaire for the analysis of musculoskeletal symptoms [26]. The workers were asked to rate the worst pain intensity of the hips, knees and feet/ankles during the last three months on a numeric rating scale from 0–10 anchored with 0: ‘no pain’ and 10: ‘worst imaginable pain’.

2.4 Assessment of possible confounders

Potential confounders were selected *a priori* based on previous literature and theoretical assumptions concerning their possible influence on standing and lower extremity pain [6,11]. Age and gender were determined from the workers’ Danish civil registration numbers. Body mass index (BMI, kg/m^2) was calculated from measured height (cm) and body mass (kg). Sector was defined according to the different occupational sectors (cleaning, transport and manufacturing). Lifting and carrying at work was assessed using a single item from the Danish Work Environment Cohort Survey: ‘How much of your working time do you carry or lift?’, using a six-point response scale ranging from 1 (“never”) to 6 (“almost all the time”). The response categories were dichotomized into low (response categories ‘never’, ‘rarely/very little’, and ‘app. ¼ of the time’) and high (response categories ‘½ of the time’, ‘¾ of the time’ and ‘almost all the time’). Influence at work was determined from two questions: “Do you have influence on what you are doing in your work?” and “Do you have influence on the amount of work you have?”. The possible answering categories were always/often/sometimes/rarely or almost never/never (1-5). The mean rating of the answers to the two questions was then transformed into a composite scale ranging 0-100, with a high score representing a high amount of influence at work.

Accelerometer measures of time spent in "Sedentary Time" (sitting and lying down) and in "Physical Activities" – moving, walking, climbing stairs, running and cycling – during total day, work and leisure were also included as potential confounders [20]. Biomechanical patterns of all postures identified as "Sedentary Time" or "Physical Activities" are previously described [19,21].

2.5 Statistical analysis

All statistical analyses were performed in IBM Statistical Package for the Social Sciences (version 22.0). Multiple linear regression analyses were performed to determine the association between total static standing time or temporal patterns (short, moderate and long bouts) of static standing (continuous independent variables) with pain in the lower extremities (continuous dependent variable). These two analyses were performed separately at work, leisure and total day and separately for hip, knee and foot/ankle pain. To avoid risk of type I error, we applied a Bonferroni correction to significance level (P value). Therefore, for all analyses, statistical significance was set at $P < 0.013$ [0.05/4 (number of tests performed per dependent variable)].

To test the robustness of the results, three sensitivity analyses were performed. Sensitivity analysis 1 was performed as a logistic regression with the same parameters for the independent variables and confounders included in the linear regression. For these analyses, the pain intensity responses were dichotomized to low < 3 and high ≥ 3, based on a previous study where workers with pain levels equal or greater than the threshold (3) have an increased risk for long-term sickness absence [27]. Sensitivity analysis 2 was performed to test if the results would change when additionally adjusting for influence at work as a covariate. Sensitivity analysis 3 consisted of a gender-stratified analysis of the data from manufacturing workers, the only group that included sufficient numbers of both genders. Visual inspection of P-P plots, scatterplots of standardized residuals against standardized predicted values and histograms of standardized residuals were used to test the assumptions of linearity, normally distributed residuals and homoscedasticity. Also, no major multi-collinearity issues between independent variables were found (tolerance index > 0.20, Variance Inflation Factors values < 5). The estimates (β and OR) on the regression models were calculated in 10 minutes increments of static standing time in relation to the lower extremity pain.

3. Results

The demographic characteristics of the workers stratified in tertiles based on standing time over the total day are shown in Table 1. Mean hours measured per day corresponded to 15.9 (1.4) hours for total day, 7.6 (1.2) hours for work time and 8.8 (1.5) hours for leisure time. On average, workers stood for 3.9 (1.3) hours during total day, 2.4 (1.1) hours during work time, and 1.6 (0.7) hours during leisure time (Table 2). The mean pain intensity was 1.3 (2.5) for hips, 2.2 (2.8) for knees and 1.6 (2.6) for feet/ankles. The prevalence of high intensity pain (≥ 3 on a scale from 0 to 10) was 20.1% for hips, 35.5% for knees and 26.1% for feet/ankles.

The results of the linear analyses are shown in Table 3. There was a positive association between total static standing time during leisure and hip (β 0.10, $p = 0.001$) and knee pain (β 0.09, $p = 0.009$). Also, short bouts of static standing increased both hip (β 0.09, $p = 0.005$) and knee (β 0.13, $p = 0.001$) pain during total day. A positive significant association between short bouts of static standing and knee pain was also found during work (β 0.13, $p = 0.002$). On the other hand, moderate bouts of static standing were negatively, but not significantly, associated with hip pain during work (β -0.09, $p = 0.03$). All associations found were weak in magnitude.

In relation to feet/ankles pain, no positive or negative associations were found for any time domain. Sensitivity analysis 1 (i.e. logistic regression – data shown in Table 4) and Sensitivity analysis 2 (i.e. adjusting for influence at work) showed no major differences to the main analysis. Sensitivity analysis 3 showed no significant interaction with gender.

4. Discussion

4.1 Static standing and lower limb pain

We found a positive association between total static standing time during leisure and hip and knee pain. Increasing 10 minutes of total time spent on static standing would lead to an increase of 0.1 (on a 0-10 scale) in hip and knee pain intensity. This minor increase in pain intensity might seem irrelevant, but the average total standing time during leisure was high in this population (1.6 h) and could therefore be of clinical relevance [27]. Because it is unlikely that workers with pain choose to stand much during leisure, the most likely interpretation is that much time spent on static standing during leisure might lead to pain in the lower extremities. Even if more variation can be added to the postures and physical activities performed during leisure, there are some activities that can be rather constrained (e.g. house holding activities – cooking, ironing -, standing during public transport, waiting in line). We are not aware of any previous studies investigating the associations between accelerometer measures of static standing during leisure time and pain in lower extremities, so we do not have appropriate previous studies to compare with. Thus, the present finding may be used to anchor changes in pain intensity in relation to different duration of static standing.

We observed a positive association of short bouts of static standing during total day with hip pain, and short bouts of static standing during total day and work with knee pain. These findings did not support our hypothesis of a negative association between short bouts of static standing and lower extremity pain. As seen for total static standing time, the estimates varied from 0.1 to 0.2 increments in pain intensity in hips and knees per 10 minutes spent in short bouts of standing. As the majority of time spent static standing occurred during short bouts (which was almost 3 hours per day for this blue-collar population), the exposure to short bouts of static standing can be of clinical significance among blue-collar workers. However, we do not interpret this finding to support that workers ought to avoid standing in short bouts for longer time of the workday [12,28]. The positive association could be explained by short bouts of static standing, here defined as no movement of the thigh, generally co-occurring with exposure to other postures and/or physical activities (e.g. lifting and carrying) which might be harmful for the lower extremities. So, there is a need to better understand how the balance between time spent in different physical activities and postures is related to musculoskeletal symptoms.

We observed moderate bouts of static standing during work to be negatively associated with hip, knee and feet/ankle pain, although the results were non-significant. These results are in line with hypothesized beneficial association of moderate standing bouts due to the variation in physical exposure and due to the mechanical assistance of the gravity while maintaining the extended hip leading to reduction of the joint reaction forces [17,29]. However, as these results were non-significant and as the study design was cross-sectional in nature, we require similar future prospective studies to confirm the beneficial association between moderate standing bouts and lower extremity pain. Additionally, the effect of replacing standing time with sitting time may yield different health effects than replacing with walking or other physical activities. Therefore, we also recommend similar future studies including more detailed patterns of all exposures including standing in relation to sitting, walking and other physical activities to better understand the association of different postures and physical activities on the worker’s pain.

Similarly, we found long bouts of static standing during total day to be positively associated with hip pain, although marginally non-significant. Specifically, we found an increase of 0.2 in hip pain intensity (0 to 10 scale) per 10 minutes increment in long bouts of standing during total day. Previous studies have found that individuals who report to stand for prolonged periods are more likely to have higher levels of discomfort in hips [7,30]. However, these studies used self-reported measures of standing which may be biased. Thus, similar previous studies using accelerometer-based temporal measures of standing on a large sample are needed to verify our results.

4.2 Limitations and Strengths of the study

The strength of this study relies on the technical quantification of static standing through several days in a large sample of almost 700 blue-collar workers. In addition, static standing was technically measured with accelerometers and analyzed with the valid Acti4 software, which is able to identify standing posture with high specificity and sensitivity [19,21]. Furthermore, the measurements were performed during both work and leisure time over several days, which gives an overview of the total exposure to standing over the day. On the other hand, a limitation of this study is the cross-sectional design, which does not permit inference about causality, particularly because of the risk for reverse causality. Thus, the consequences of total static standing time and temporal patterns of static standing on pain in lower extremities need to be further investigated with technical measurements in longitudinal designs and interventions. Also, the associations found were weak and the temporal patterns of static standing are likely to explain only a small variation of lower extremity pain. Lack of information on the prior history of lower limb joint injury and on the ability of the workers to control their posture are a limitation of the study. Moreover, the lifting or carrying of loads was not technically measured in our study, but based on self-reported information, which can be imprecise and biased.

5. Conclusion

The associations found in this study even though weak, suggest that short and long bouts of standing, as well as total static standing time might impose a harmful effect on the lower extremity pain. However, the time pattern of static standing also is of importance for lower extremity pain, and that a strategy to promote variation in standing into moderate bouts (5-10 min) might be beneficial. However, this preventive strategy for lower extremity pain needs to be investigated by prospective observational studies and interventions before being implemented.

Conflict of interest

All authors have not any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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Figure 1

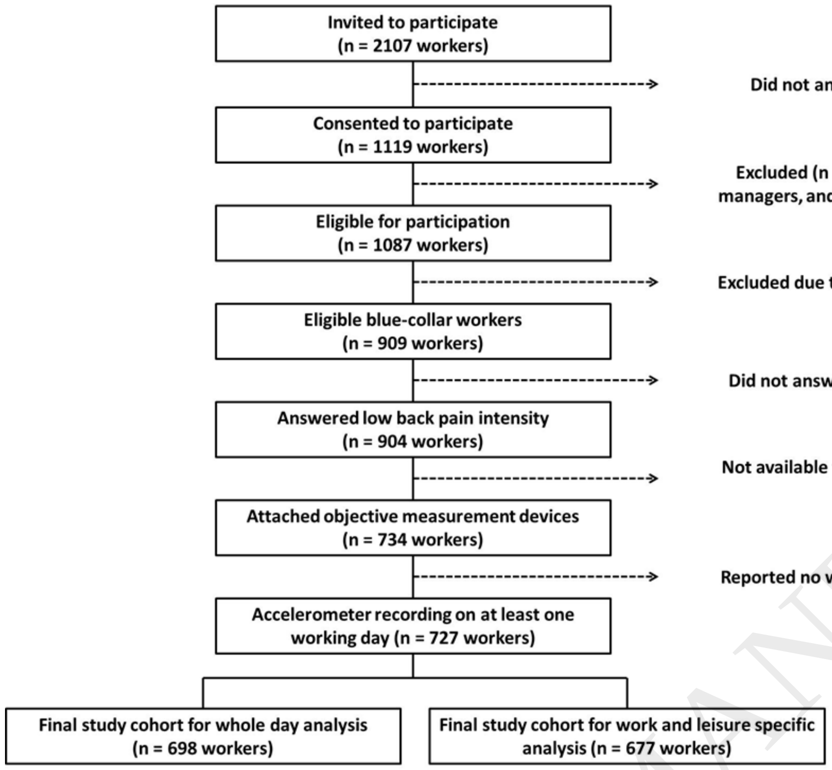
Invited to participate
(n = 2107 workers)
Did not announce interest (n = 988)
Consented to participate
(n = 1119 workers)
Excluded (n = 32 (2 pregnancy, 17 were managers, and 13 were students/trainees))
Eligible for participation
(n = 1087 workers)
Excluded due to white-collar work (n = 186)
Eligible blue-collar workers
(n = 909 workers)
Did not answered to LBP intensity (n = 5)
Answered low back pain intensity
(n = 904 workers)
Not available for objective measurements
(n = 170)
Attached objective measurement devices
(n = 734 workers)
Reported no working hours per day (n = 7)
Accelerometer recording on at least one working day (n = 727 workers)
Final study cohort for whole day analysis
(n = 698 workers)
Final study cohort for work and leisure specific analysis (n = 677 workers)

Table 1. Demographic characteristics of the study population of blue-collar workers from DPHACTO (n = 698) also stratified in tertiles based on standing time over the total day (Low: n = 232, Moderate: n = 233, High: n = 233).

Variables	**Total**	**Low (< 3.3 h)**	**Moderate (3.3 h – 4.4 h)**	**High (> 4.4 h)**
Age, years - Mean (SD)	45.1 (9.9)	45.5 (9.8)	44.2 (10.2)	45.4 (9.8)
BMI, kg/m^2 - Mean (SD)	27.5 (4.87)	27.8 (4.8)	27.3 (4.5)	27.2 (5)
Seniority, years - Mean (SD)	12.9 (10.1)	11.7 (9.6)	13.6 (9.9)	13.6 (10.5)
Male – n (%)	376 (53.9)	134 (57.8)	129 (55.4)	113 (48.5)
Smokers – n (%)	208 (29.8)	66 (29.1)	75 (32.9)	67 (29.8)
Pain intensity (0-10)				
Hips	1.3 (2.5)	1.3 (2.5)	1.2 (2.4)	1.4 (2.5)
Knees	2.2 (2.8)	2.1 (2.7)	1.9 (2.7)	2.5 (2.9)
Feet/Ankles	1.6 (2.6)	1.3 (2.3)	1.6 (2.7)	1.9 (2.8)
Sector				
Cleaning, n (%)	138 (19.8)	58 (25.0)	47 (20.1)	33 (14.2)
Manufacturing, n (%)	493 (70.6)	116 (50.0)	177 (76.0)	200 (85.8)
Transportation, n (%)	67 (9.6)	58 (25.0)	9 (3.9)	0 (0)
High occupational lifting time – n (%)	394 (56.9)	166 (72.2)	123 (52.8)	105 (45.7)
Mean hours measured per day				
Total day while awake, Mean (SD)	15.9 (1.5)	15.6 (1.7)	15.8 (1.2)	16.3 (1.2)
Work time, Mean (SD)	7.6 (1.2)	7.4 (1.5)	7.5 (1.1)	7.8 (1.1)
Leisure time, Mean (SD)	8.8 (1.5)	8.7 (1.5)	8.7 (1.5)	8.9 (1.4)
Mean days measured				
Total day while awake, Mean (SD)	2.9 (0.9)	2.7 (0.9)	3.1 (0.9)	2.9 (0.8)
Work and Leisure time, Mean (SD)	2.6 (0.9)	2.5 (0.9)	2.8 (0.9)	2.6 (0.9)
***Sedentary time in hours per day**				
Total day while awake, Mean (SD)	7.8 (2.1)	9.3 (2.2)	7.68 (1.5)	6.5 (1.3)
Work time, Mean (SD)	2.4 (1.7)	3.5 (2)	2.29 (1.4)	1.5 (1.4)
Leisure time, Mean (SD)	5.5 (1.4)	5.9 (1.6)	5.49 (1.2)	5 (1.3)
***Physical Activities in hours per day**				
Total day while awake, Mean (SD)	4.1 (1.3)	3.6 (1.3)	4.3 (1.2)	4.4 (1.2)
Work time, Mean (SD)	2.6 (1.1)	2.3 (1.2)	2.8 (1)	2.7 (1)
Leisure time, Mean (SD)	1.6 (0.6)	1.5 (0.6)	1.6 (0.6)	1.8 (0.6)

n = number of workers; SD = standard deviation; BMI = Body Mass Index

**Sedentary time: sit and lie; Physical Activities: move, walk, run, climbing stairs and cycle*

Table 2. Total time standing and temporal patterns of standing (short, moderate and long bouts) during the total day, work and leisure time among 677 blue-collar workers.

	Total day		Work time		Leisure time	
	Hours	%	Hours	%	Hours	%
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Total standing time	3.9 (1.3)	24.8 (7.9)	2.4 (1.1)	32.2 (13.7)	1.6 (0.7)	18.7 (7.1)
Short Bouts (0-5 min)	2.7 (0.8)	17.3 (5.2)	1.7 (0.7)	23.2 (9.2)	1.1 (0.4)	12.7 (4.4)
Moderate Bouts (>5-10 min)	1.1 (0.6)	6.8 (3.8)	0.6 (0.5)	8.7 (6.6)	0.4 (0.2)	5.3 (3.1)
Long Bouts (> 10 min)	0.1 (0.2)	0.7 (1.3)	0.1 (0.1)	0.9 (2.7)	0.1 (0.1)	0.7 (1.2)

%: percentage of time spent standing in relation to all physical activities performed during the total day, work or leisure;

n = number of workers; SD = standard deviation

The standing durations during work and leisure time do not add up to the numbers for the total day due to differences in inclusion criteria

Table 3. Linear regression analysis of the association between total standing time and temporal patterns (short, moderate and long bouts) of standing in increments of 10 minutes during total day, work and leisure time respectively and lower extremities (hips, knees, feet/ankles) pain intensity (scale 0-10) among 677 blue-collar workers.

	Total day		Work time		Leisure time	
	β (95% CI)	**p**	**β (95% CI)**	**p**	**β (95% CI)**	**p**
Hips						
Total standing time	0.03 (-0.01 – 0.06)	0.08	-0.01 (-0.04 – 0.03)	0.72	**0.10 (0.04 – 0.15)**	**0.001**
Short Bouts (0-5 min)	**0.09 (0.03 – 0.15)**	**0.005**	0.06 (-0.01 – 0.13)	0.09	0.09 (-0.04 – 0.23)	0.17
Moderate Bouts (>5-10 min)	-0.06 (-0.14 – 0.01)	0.10	-0.09 (-0.17 – -0.01)	0.03	0.08 (-0.10 – 0.26)	0.39
Long Bouts (>10 min)	0.20 (0.01 – 0.38)	0.03	0.11 (-0.10 – 0.32)	0.3	0.16 (-0.16 – 0.48)	0.32
Knees						
Total standing time	0.03 (-0.01 – 0.06)	0.11	0.03 (-0.01 – 0.07)	0.17	**0.09 (0.02 – 0.15)**	**0.009**
Short Bouts (0-5 min)	**0.13 (0.06 – 0.20)**	**0.001**	**0.13 (0.05 – 0.21)**	**0.002**	0.19 (0.03 – 0.35)	0.017
Moderate Bouts (>5-10 min)	-0.07 (-0.16 – 0.02)	0.14	-0.07 (-0.17 – 0.02)	0.12	0.03 (-0.18 – 0.24)	0.75
Long Bouts (>10 min)	0.06 (-0.14 – 0.27)	0.53	0.08 (-0.15 – 0.32)	0.49	-0.10 (-0.47 – 0.27)	0.59
Feet/ankles						
Total standing time	0.02 (-0.02 – 0.05)	0.32	0.01 (-0.03 – 0.05)	0.57	0.06 (-0.01 – 0.12)	0.07
Short Bouts (0-5 min)	0.06 (-0.01 – 0.13)	0.06	0.04 (-0.03 – 0.12)	0.23	0.08 (-0.07 – 0.23)	0.3
Moderate Bouts (>5-10 min)	-0.05 (-0.13 – 0.04)	0.26	-0.03 (-0.12 – 0.05)	0.43	0.04 (-0.16 – 0.24)	0.7
Long Bouts (>10 min)	0.11 (-0.08 – 0.31)	0.26	0.09 (-0.13 – 0.31)	0.43	0.02 (-0.33 – 0.37)	0.9

Results show the change in pain levels by increasing 10 minutes of standing.

Adjusted for age, BMI, gender, sector, occupational lifting/carrying time, sedentary time (sit and lie), and time spent in physical activity (move, walk, run, climbing stairs, cycle)

Statistically significant differences are marked in bold

Table 4. Sensitivity analysis 1 - Logistic regression analysis of the association between total standing time and temporal patterns (short, moderate and long bouts) of standing in increments of 10 minutes during total day, work and leisure time respectively and high lower extremities (hips, knees, feet/ankles) pain intensity (> 2 on scale 0-10) among 677 blue-collar workers.

	Total day		**Work time**		**Leisure time**	
	OR (95% CI)	**p**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Hips						
Total standing time	**1.04 (1.01 – 1.07)**	**0.02**	0.99 (0.97 – 1.02)	0.78	**1.07 (1.02 – 1.12)**	**0.01**
Short Bouts (0-5 min)	**1.10 (1.02 – 1.17)**	**0.01**	1.07 (0.98 – 1.15)	0.09	0.97 (0.88 – 1.07)	0.61
Moderate Bouts (>5-10 min)	0.97 (0.89 – 1.05)	0.46	**0.90 (0.81 – 0.99)**	**0.04**	**1.27 (1.07 – 1.50)**	**0.01**
Long Bouts (>10 min)	1.19 (1.00 – 1.41)	0.05	1.14 (0.94 – 1.38)	0.16	0.96 (0.71 – 1.29)	0.79
Knees						
Total standing time	1.02 (0.99 – 1.05)	0.08	1.02 (0.99 – 1.06)	0.12	**1.04 (1.01 – 1.07)**	**0.04**
Short Bouts (0-5 min)	**1.10 (1.04 – 1.16)**	**0.01**	**1.10 (1.03 – 1.17)**	**0.01**	1.05 (0.97 – 1.13)	0.23
Moderate Bouts (>5-10 min)	0.95 (0.89 – 1.02)	0.19	0.94 (0.87 – 1.01)	0.11	1.05 (0.91 – 1.22)	0.47
Long Bouts (>10 min)	1.11 (0.94 – 1.29)	0.21	1.16 (0.97 – 1.38)	0.10	0.94 (0.71 – 1.24)	0.68
Feet/ankles						
Total standing time	1.01 (0.98 – 1.04)	0.29	1.01 (0.97 – 1.05)	0.74	1.04 (1.01 – 1.08)	0.03
Short Bouts (0-5 min)	1.02 (0.96 – 1.08)	0.42	1.02 (0.95 – 1.09)	0.53	1.01 (0.92 – 1.09)	0.98
Moderate Bouts (>5-10 min)	0.98 (0.91 – 1.06)	0.69	0.97 (0.89 – 1.05)	0.50	1.16 (0.99 – 1.35)	0.06
Long Bouts (>10 min)	1.09 (0.93 – 1.29)	0.25	1.13 (0.94 – 1.35)	0.18	0.87 (0.64 – 1.18)	0.38

Adjusted for age, BMI, gender, sector, occupational lifting/carrying time, sedentary time (sit and lie), and time spent in physical activity (move, walk, run, climbing stairs, cycle)

Statistically significant differences are marked in bold